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GENERAL NOTES.

Definitive Orbit of Comet 1844II (MAUVAIS).—A definitive orbit of this comet has been published, in a supplement to the *Astronomische Nachrichten,* by FRANK E. ROSS, Ph.D., a former student in astronomy at the University of California and Fellow at the Lick Observatory. Dr. ROSS starts with an orbit by PLANTAMOUR, published in 1847, reduces the observations, computes the perturbations by *Venus,* Earth, *Saturn,* and *Jupiter,* and corrects PLANTAMOUR'S elements. The agreement between theory and observation is decidedly improved, the corrected orbit passing through all but one of the normal positions within about two seconds of arc.

Two Articles on Cometary Motion.—A recent number of the *Publications* contained a note on stationary meteor-radiants in which the question of the origin of comets and meteors was referred to. It is probable that some of these bodies are strangers from the depths of space, to which they return after a single visit to the Sun's system. Others are known to be moving in elliptic orbits, and so, temporarily at least, to belong to the solar family. Comets approaching the Sun on nearly parabolic orbits have suffered perturbations which have added them to the class of "periodic" comets, and in the case of LEXELL'S lost comet the period was shortened by one approach to *Jupiter,* only to be lengthened again a few years later by a second approach to the same planet.

Any theory to account for the origin of comets and meteors must be based upon or include answers to the two questions: Are most of the orbits originally elliptic or hyperbolic? Are the elliptic orbits stable, or will perturbations some day change the elliptic orbits into hyperbolic ones?

Number 4058 of the *Astronomische Nachrichten* contains "A Theorem Regarding Comet Perturbations," by Dr. ELIS STROEMGREN, which makes an important contribution to the methods used in gaining data for the answer to the first question. He gives an abridged method for determining by mechanical integration the perturbation of the major axis of an elliptical comet-orbit from the date of osculation backwards as far as is necessary for the subsequent investigations, and produces an expression for the upper limit of the total perturbation of the major axis from the beginning of the perturbative effect until the time to which the perturbation is thus carried back. The length of the interval during which the process of mechanical integration must be employed depends upon the eccentricity of the original orbit, being longer the less this eccentricity differs from unity.

The December number of the *Bulletin Astronomique* contains a memoir by M. H. v. ZEIPEL, " On the Instability of the Movement of the Comets," which has an important bearing upon the answer to the second of the above questions. He considers first an ideal case in which two bodies move in circular orbits about their common center of gravity, a third body of negligible mass having entered this system and been captured by it. Although the planets do not move in circles, the orbits of the greater planets are, roughly speaking, not far from circular, and the first system treated by v. ZEIPEL may be regarded as a fair approximation to the state of affairs in the solar system when a comet, entering the system on a hyperbolic orbit, is " captured " by the perturbations of one of the major planets. He shows that in this ideal case the captured comet would at some future time be expelled from the system.

Taking up the more general case when the two chief bodies of such a three-body system move in ellipses, v. ZEIPEL shows that the third body of negligible mass (supposed to have been captured as comets may be captured by the major planets) would at some future time be expelled, except in certain exceptional cases, whose occurrence is infinitely improbable.

This theorem follows also as a corollary to the discussion by POINCARÉ at the close of chapter XXVI of his *Méchanique Céleste,* though no mention is made there of an application to periodic comets.

It is to be remembered that these theories take no account of the chances of collision between the comet and one of the other bodies.

These theorems regarding the expulsion of third bodies entering a system of two bodies furnish foundation for a conviction that if the periodic comets are really visitors from the outside universe they will some day be expelled through the perturbations of the body that captured them, provided they are not first disintegrated by close approach to (or collision with) some of the members of the solar system. It is, however, improbable that the comets are, in general, strangers from outer space, visiting the solar system for the first time. Out of several hundred cometary orbits that have been computed, not more than a half-dozen show evidence of being hyperbolic, and in these instances the evidence is inconclusive.

If the comets were really visitors in the Sun's system, having had no previous connection with it, we should expect to find most of their orbits decidedly hyperbolic. If the three or four hundred comets entering on nearly parabolic orbits are visitors in the sense above indicated, their original motion in space must have been the same in direction and velocity as that of the Sun's system. In other words, the velocity of these bodies with respect to the Sun must have been zero. The stars are in motion with reference to the Sun's system, and with an average velocity of some twenty miles a second. We should expect the same thing to be true of smaller bodies moving independently through space,—namely, that their velocities with respect to the Sun would be some twenty miles per second. That the original motion of the cometary masses was identical in magnitude and direction with that of the Sun certainly argues some connection with the solar system, possibly of the sort referred to in the note on stationary meteor-radiants above mentioned. B. L. N.

A Test of a Transit Micrometer. By JOHN F. HAYFORD. *Report of the U. S. Coast and Geodetic Survey,* 1904, App. No. 8; pp. 453-487, two plates. Separate. Washington, 1904. —In this interesting and important monograph the author presents to that portion of the American scientific public which does not keep in touch with scientific progress in foreign lands a new method of observing star transits—a method which, we may confidently assert, is to revolutionize that art. The old or present method consists essentially in noting the time when the moving star-image in the focus of a telescope crosses a fixed line. In this radically new method, on the other hand, the observer maintains a steady bisection of the star-image on a movable micrometer-thread, while the electric signals are made on the chronograph automatically by the rotating micrometer-head.

The peculiar piece of apparatus required for this operation was first successfully devised and constructed by Dr. J. REPSOLD, of Hamburg, in 1889, and may be adapted to any form of transit instrument. It is called in English the "Transit Micrometer." To those familiar with the work of the German observers who have already made use of Dr. REPSOLD'S device through a number of years there could be no question of the marked superiority of the new method.

The author's particular purpose, however, was to investigate, in behalf of the U. S. Coast and Geodetic Survey, the desirability of applying the new micrometer to the straight type of transit instrument now and hitherto in use by the Survey, with the view of improving its determinations of longitude. This he has done in a thorough manner, with the aid of Mr. E. G. FISCHER, of the Survey, who devised a transit micrometer for use in the experiments and as a model for possible adoption by the Survey. Mr. FISCHER contributes also a clear and full description of the micrometer, so that the reader, with the aid of the two large plates, can understand the apparatus in all its details. The only material difference from REPSOLD'S design is, that an ingenious provision is made for cutting out the automatic signals except in just that part of the field where they are wanted. Mr. HAYFORD presents the results of the experimental observations and their discussion in a complete manner and in a very clear style. He made about one half of the observations himself, starting with no previous experience with this kind of work; and he called in the services of fifteen other observers, whom he divides into four classes, from those with experience in astronomical observing and in good training to those who had had little experience with instruments of precision of any sort or at any time. By this *a fortiori* method he demonstrates the superiority of the transit micrometer; and while some of the work seems to the astronomical reader very crude for publication and the professional feels somewhat aggrieved at this public introduction of neophytes into his sacred domain, it must be remembered that Mr. HAYFORD is in the position of having to make a special plea.

With his good instrument and this medley of observers, Mr. HAYFORD shows, among other conclusions:—

1. That the relative personal equation, that bugbear of astronomers in determining star positions and terrestrial longitudes practically vanishes,—that is, it is less than $0^s.050$ in any case.

2. That he is justified in predicting that three nights of observing by the new method and without exchange of observers will serve to determine a longitude as accurately as ten nights of observing by the old method including an exchange of observers—a great economy of time and transportation.

3. That, for a practiced observer, the new method is truly equivalent to maintaining bisection upon a stationary point of light, and that the absolute or angular accidental error of observation is the same for all stars throughout the range of declination.

4. That good observations can be secured without previous practice.

5. That, owing to the rapidity with which the automatic signals can be recorded, a greater number of stars can be observed in a given time. The author states that his observing-list contained sixteen stars per hour to ten stars per hour in the customary lists of the Survey.

Mr. HAYFORD's fourth conclusion, as given above, when we consider the immense advantages of the method, is not so extravagant as it seems. However, the author would of course prefer an observer at the outset at least accustomed to the manipulation of delicate instruments. As the author notes, the remarks of observers at beginning plainly indicate their perturbation of mind as well as of hand in attempting to following a fast-moving star. But the persistent observer may be assured that some fine night there will come the satisfaction of seeing the star-images "go to sleep" on the apparently stationary thread. Mr. HAYFORD remarks that more practice simply reduces the accidental error by about twenty-five per cent. The present writer has had some experience with the new micrometer on a larger instrument. He found that his probable error of a single star-signal started at $\pm 0^s.07$ after observing a number of stars, and became $\pm 0^s.030$, under favorable conditions, after considerable practice scattered over a number of months, or the same as for the old key method. As in the making of a telescopic objective, it is the last stages of improvement that take by far the most time and care.

In this connection, also, it may be remarked that Mr. Hayford calls attention, in the course of his discussion, to two or three "curious facts" which cropped out in the course of his investigations; but he does not mention the fact, as shown in his Table V, that one observer, belonging to his very lowest class, takes the prize in the form of the smallest probable error of a single observation of a star,—not a large amount of data involved, it is true, but more than for some of the other observers. Ladies always catch the largest fish in camping-parties, and here a young woman seems to incur the smallest error.

It should be admitted that all the advantages are not with the new micrometer; though its disadvantages, so far as seen, concern only the physical comfort of the observer, especially in cold weather. With the old method one could wear heavy gloves, but would hardly attempt to do so while turning a delicate micrometer. With the old method eye and hand could enjoy little intervals of rest between threads, while with the new both must be kept steadily at work; but this is modified if one is content with a short series of many signals close together, and with long practice the feeling of intense strain wears away. Still, it is the writer's experience that any unexpected noise or incident is more disturbing than with the old method. But, of course, such incidents rarely occur in well-regulated observing.

Mr. Hayford's conclusions are all borne out by the experience of the German observers. They have found the relative personal equations reduced to one tenth of their former value, and so small as to be masked, if existing at all, by the minute outstanding accidental error. Albrecht found that the mean error of a single night's determination of longitude was reduced from values between $\pm 0^s.043$ and $\pm 0^s.064$ to values between $\pm 0^s.020$ and $\pm 0^s.026$. Also, they have found their results singularly free from systematic errors of all kinds, and that a moderate amount of practice suffices for making tolerably good observations.

The last section of Mr. HAYFORD'S publication is a review of the literature of the transit micrometer. To a professional reader this is the most important part; for, as already noted, Mr. HAYFORD'S work had a special purpose, while here he gives an excellent summary of a list of fifteen different publications—all but one by "those blessed Germans"—extending over the past sixteen years. The first published suggestion of this method came from Director CARL BRAUN, of Kalocsa, Hungary, in 1865. He attempted to construct a clockwork which should drive the movable thread, but was unsuccessful. This has been completely accomplished of recent years; but the observer's hand is required to maintain the finishing touch on the micrometer. Doubtless during the years following BRAUN'S first publication, there were many suggestions among astronomers to the same purpose; and the author records one definitely made by Mr. F. D. GRANGER, of the Coast Survey, in 1878.

Following closely upon the announcement by REPSOLD of the successful performance of his first transit micrometer, verifications of its superiority were presented in 1890 and 1891 by Dr. TH. ALBRECHT before the (European) International Geodetic Association and by Professor E. BECKER, who had applied the new micrometer to transits of the broken type. In a publication of the Prussian Geodetic Institute in 1901, ALBRECHT declared that the superiority of the new method was so complete that it should be employed in all primary longitude work. The experience of OERTEL and COHN in Germany and of the Washburn Observatory in this country with the new micrometer on meridian-circles—as transit instruments of the straight telescope type—demonstrated its superiority for the larger observatory instruments. And there would seem to be left no question of the desirability of the new micrometer for the present instruments of the U. S. Coast and Geodetic Survey. A. S. FLINT.

The Fifth Satellite of Jupiter.—Number 580 of the *Astronomical Journal* contains an article by Professor E. E. BARNARD, giving a long series of observations of the fifth satellite of *Jupiter,* made with the large refractor of the Yerkes Observatory during the years 1903 and 1904. These measures, as well as previous ones by the same observer, were made by measuring with a micrometer the distance of the satellite from the limb of *Jupiter,* and then applying a reduction factor for the semi-diameter of the planet. The values of the reduction factor were taken from a table previously constructed by Professor BARNARD from an elaborate series of observations of the apparent diameter of *Jupiter.* A few measures were made by determining distance and position-angle of the fifth satellite with respect to one of the brighter satellites. The two methods are quite different, and each has its advantages and each its disadvantages.

There is a third method of determining the position of a satellite which seems not to be used by observers of these objects. Why should not the position of a satellite be determined in the same way that the position of a comet or an asteroid is determined,—namely, by measuring its position on the sky with respect to a star or stars of known coordinates? Such observations can be made as accurately, and in most cases more accurately, than by either of the two methods usually employed; and it would seem, theoretically at least, to be a decided advantage to the computer who handles the observations to have the position of the satellite referred to fixed points rather than to constantly moving points. The object of all observations of position of satellites is to obtain material from which to compute the orbit of the body, and this can be done as easily, or more easily, from accurate right ascensions and declinations of the body than from the observations ordinarily made.

This question is worth looking into, and I hope at no very distant date to examine it more critically in order to determine just what observations should be made upon a satellite in order to compute the elements of its orbit with the greatest possible accuracy and facility. It may be that a combination of the observations mentioned should be made. S. D. T.

Figure of the Sun.—In number 104 of these *Publications* attention was called to an article by Dr. C. L. POOR on the variable figure of the Sun. In the *Astrophysical Journal* for

December Dr. Poor has contributed a second article on the same subject. This second article deals with the results obtained from an elaborate series of observations upon the diameter of the Sun made by Messrs. Schur and Ambronn, with a six-inch Repsold heliometer of the Göttingen Observatory. These observations extend over a whole sun-spot period, from 1890 to 1902.

Dr. Poor finds in these observations further confirmation of the deductions obtained from his previous investigations,—namely, that the equatorial diameter of the Sun increases, with respect to the polar diameter, at the same time that the number of spots increases, and *vice versa.* The amount of the variation in the ratio between the equatorial and the polar diameters, however, is not so great in the observations of Schur and Ambronn as was obtained from the Rutherford photographs.

The *Astronomische Jahresbericht,* prepared hitherto by the late Professor Wislicenus, will now be undertaken by Professor Berberich, of the Recheninstitut in Berlin.

The following notes have been taken from recent numbers of *Science*:—

The Paris Academy of Sciences has awarded the Lalande prize to Professor William Henry Pickering, of Harvard University, for his discovery of the ninth and tenth satellites of *Saturn.*

At the New York meeting of the Astronomical and Astrophysical Society of America, on December 28-30, 1905, the following officers were elected for the ensuing year: President, E. C. Pickering; First Vice-President, G. E. Hale; Second Vice-President, W. W. Campbell; Secretary, G. C. Comstock; Treasurer, C. L. Doolittle; Councilors, E. B. Frost and Harold Jacoby. Councilors Ormond Stone and W. S. Eichelberger hold over from the preceding year. The time and place of the next meeting will be determined by the Council.

The will of the late Charles T. Yerkes, who owed his large fortune to the direct application of recent advances in science, makes provision for three important institutions, which are to bear his name. The Yerkes Observatory, to which he has already contributed liberally, receives one hundred thousand dollars; the Yerkes Galleries and the Yerkes Hospital are to be established in New York City on the death of his widow, or sooner, should she wish.

The Late Astronomer Royal of Ireland.—Mr. CHARLES J. JOLY died at Dunsink Observatory, Dublin, on the 4th of January last. He was educated at Galway, and in 1882 entered Dublin University, where he had an academic career of the highest distinction. In 1886 he took the mathematical studentship and first place in science among the men of his year. Eight years later he was elected a Fellow of Trinity College, and identified himself closely with the advanced scientific teaching of that institution. In 1897 he succeeded Mr. A. RAMBAUT as the Astronomer Royal of Ireland. This post is attached to the Andrews Professorship of Astronomy, which was founded at Dublin University in 1783. The tenant of both offices resides at Dunsink Observatory, which is five miles outside Dublin, and is used both for independent observation and as the university school for the teaching of astronomy. Mr. JOLY was efficient both as a student and as a teacher of that science, and he maintained the high reputation of his chair, which has given to England in the past Sir ROBERT BALL, Mr. RAMBAUT, and other eminent scientists. He was a member of the Royal Society and of other learned associations. He was forty-one years of age.—*Extract from the Times.*

New Astronomer Royal for Scotland.—Mr. F. W. DYSON, F. R. S., Chief Assistant, Royal Observatory, Greenwich, has been appointed Astronomer Royal for Scotland, and also Professor of Practical Astronomy, Edinburgh University. Mr. DYSON studied at Cambridge, and was second wrangler and Smith's prizeman in 1889, and also Isaac Newton student. He is Secretary of the Royal Astronomical Society, and has published contributions on mathematical and astronomical subjects.—*Extract from the Times.*